ESSAI

Volume 3 Article 18

Spring 2005

# Biodiversity of the Macroinvertebrate Community in a Re-created Tallgrass Prairie as Affected by Exclusion of Mammalian Predators

Valentine Kopjo
*College of DuPage*

# Biodiversity of the Macroinvertebrate Community in a Re-created Tallgrass Prairie as Affected by Exclusion of Mammalian Predators

by Valentine Kopjo

(Honors Biology 110)

The Assignment: Conduct original research and write a technical paper about the research.

## Abstract

Mammalian predators were excluded from given sections of a re-created tallgrass prairie in Northeastern Illinois. The effects of this exclusion were measured through observation and sampling of macroinvertebrate species. Results were taken from the area where mammalian predators were excluded after a 5-year period of time and also from a random area two meters away which served as a control. The pH and temperature measurements of the soil were also taken at each site, and an inventory of plants in the area was recorded. Species assemblages of macroinvertebrates and flora were more similar among the 7 exclusion sites than among the 7 control sites. Predator exclusion can explain this observation where the macroinvetebrate communities in enclosures shifted in a common way which affected the flora via grazing. Alternatively, the observation may reflect bias from the original re-creation efforts.

## Introduction

Because species do no exist in isolation but, rather, are embedded in more complex interactions, the affect which mammalian predators have upon the dynamics and biodiversity of macroinvertebrate communities can aid in understanding and learning about re-created systems and their processes (Bonsall, 2003). If predators choose to prey upon only one species of macroinvertebrates, then that predator can dramatically change the age distribution of that species. Conversely, if the predator eats only the reproducing members of a population, the population will decrease greatly come the next period of birth. Through these feeding habits, the predators then can decrease the survivorship of certain prey species and also change vital rates of reproduction and growth (Nakaoka, 2000). When the effects of predation upon the hard clam *Mercenaria mercenaria* were studied in the estuaries of North Carolina, it was shown that growth rates were lower in habitats where predation rates were higher (Nakaoka, 2000). If a population is preyed upon for a long period, its population can severely decrease. As the prey population decreases, the predation rate also decreases because the abundance of that prey species becomes rare in comparison to other prey species. Because the decrease in prey population equals less food for the predator, the predator will divert attention to other, more abundant prey species (Khan, et al 2004).

Because predators tend to prey more upon those species which are abundant and small in size, the macroinvertebrate community becomes key in understanding life in re-created systems such as the tallgrass prairie (Khan and Ghaleb 2002). Ecological processes of the prairie can often be connected to the activities of insects. Avian and mammalian predators depend upon the abundance and location of food sources, including insects, to determine where to breed. Plant distribution is affected by insect pollination, seed predation, and grazing (Costello, 1969). If not controlled, herbivores can severely disturb the plant community. Prey species can also affect the availability of flora because, in addition to ingesting macroinvertebrates, many species also ingest plants. The gray fox, *Urocyon cinereoargenteus*, has been examined and found to ingest plants, including various nuts and berries, in addition to the macroinvertebrates they regularly consume (Bauer, 1988). Consequently, factors that regulate macroinvertebrate populations help in understanding the stability and management of re-created systems.

A re-created system was examined in the paper to determine how the biodiversity of the macroinvertebrate community is affected by the exclusion of mammalian predators. Based upon knowledge of predator-prey relationships, predictions of this study conclude that there will exist some sort of effect on the macroinvertebrate community within the re-created tallgrass prairie of Northeastern Illinois. As much of the original tallgrass prairie has been destroyed, endangering many species, the understanding of community dynamics gained in this study was presumed helpful in preserving the remnant diversity in re-created systems (Madson, 1993).

## Methods

A search for specimens was conducted in September 2004 in the 15 ha Russel Kirt re-created tallgrass prairie, which began in 1985. Kirt (1996) provides description of the flora community of the prairie. The seven 2m x 2m enclosures which were specifically studied were established five years ago and are scattered along the perimeter of a retention pond which is also a part of the re-created tallgrass prairie. Galvanized chicken wire was buried to a depth of 15 cm and extended to a high of 30 cm. The 5 mm mesh size acts to prevent invasion by larger mammalian predators including shrews, fox, and raccoons. Controls were selected based on being within 2 m of the enclosures and along the same approximate slope proceeding to the retention pond. Macroinvertebrates were inventoried from the enclosures in which mammalian predators were excluded and also from the controls two meters away according to morphotype as well as to the lowest taxonomic level possible. At each area from which macroinvertebrates were collected, pH level and temperature of soil was recorded using an Aquaterr Temp-200 meter (Aquaterr Instruments, Costa Mesa, CA). Also, inventories were done on all flora seen in both enclosed and controls.

Assemblage structures of the macroinvertebrate communities and floral communities were summarized using correspondence analysis. The ordination technique offers to reduce community data to coordinates on a multidimensional plane. Only the first two dimensions were considered here as they explain most of the variance in data. Communities which are more similar should have coordinates that are closer together than communities which are less similar.

## Results

Lists of macroinvertebrates and flora can be obtained by contacting College of DuPage. Table 1 provides the first two-dimensional coordinates from the correspondence analysis of the macroinvertebrate communities and floral communities, in addition to the soil temperature and moisture at 10cm. Figures 1 and 2 provide a plot of ordinated data of the macroinvertebrate and flora communities using the first two dimensions of correspondence analysis, respectively.

Ordinated assemblance structures of macroinvertebrates and flora communities were more similar in enclosures than controls.

## Discussion

Explanations to the similar assemblages of macroinvertebrates and flora among controls include the thought that human involvement when first creating the enclosures determined which plants, and consequently which species of macroinvertebrates, were to be found in each area. Alternatively, the exclusion of mammalian predators may have caused the succession sequence of macroinvertebrates among enclosures, which was propagated to the plant community by grazing pressures.

It also must be taken into consideration that flora species may be similar as a result of excluding mammalian consumers from the enclosed areas. If consumers are unable to enter the enclosed areas, then certain plants which would otherwise be consumed are allowed to flourish. This would account for similarities in flora species not only in enclosures but also in the control areas. The flora species in the control areas would be more alike because they were equally available to predators. Macroinvertebrate species in controls would also then be more alike because the flora species upon which they depend would be similar. The same logic holds true for the macroinvertebrate species in the enclosures. If the same macroinvertebrates were found, then the same species of mammalian predators may have been found preying upon the species. Additionally, higher variance among controls in macroinvertebrate and floral assemblages may reflect uneven distribution of mammalian predators in the re-created system. However, neither the abundance of predators in enclosures nor control areas was observed. Each track of hypothesis needs to be further scrutinized to determine the effects of excluded mammalian predators on the macroinvertebrate communities of the re-created tallgrass prairie.

---

## Works Cited

Bauer, E. 1988. Predators of North America. Grolier Books, Latham, NY.

Bonsall, M.B. 2003. The role of variability and risk on the persistence of a shared-enemy, predator-prey assemblages. Journal of Theoretical Biology 221: 193-204.

Costello, D. F. 1969. The Prairie World. Crowell Company, New York, NY.

Khan, Q.J.A., A. Balakrishnan, and C. G. Wake, 2004. Analysis of a predator-prey system with predator switching. Bulletin of Mathematical Biology 66: 109-123.

Khan, Q.J. A., and A.F. Ghaleb, 2002. A study of prey-predator relations for mammals. Journal of Theoretical Biology 223: 171-178.

Kirt, R. R. 1996. A nine-year assessment of successional trends in prairie plantings using seed broadcast and seedling transplant methods, p. 144-153. In: C. Warwick (ed.). Fifteenth North American Prairie Conference, The Natural Areas Association, Bend, OR.

Madson, J. 1993. Tallgrass Prairie: A Nature Conservancy Book. Falcon P, Helena.

Nakaoka, M. 2000. Nonlethal effects of predators on prey populations: predator-mediated change in bivalve growth. Ecology 81: 1031.

Table 1. First two dimensional coordinates from correspondence analysis (CA) of the macroinvertebrate communities and floral communities, soil temperature at 10 cm depth, and soil moisture at 10 cm depth according to sample site. Symbols: Ei = enclosure site i and Ci = control site i.

| Site | Macroinvertebrate community coordinates of CA | | Soil temperature ($C^o$) | Soil moisture (%) | Floral community coordinates of CA | |
|---|---|---|---|---|---|---|
| | Dim 1 | Dim 2 | | | Dim 1 | Dim 2 |
| E1 | 0.35 | -0.35 | 25.8 | 37 | -0.30 | -0.45 |
| E2 | -0.21 | 0.47 | 26.1 | 40 | -0.91 | 0.94 |
| E3 | 0.75 | 0.53 | 26.7 | 54 | 0.22 | -0.11 |
| E4 | 0.67 | 0.63 | 27.2 | 52 | 0.33 | -0.11 |
| E5 | -0.49 | 0.22 | 26.7 | 61 | 0.13 | 0.21 |
| E6 | 0.32 | -0.69 | 27.2 | 58 | -0.56 | 0.34 |
| E7 | 0.10 | 0.20 | 26.7 | 47 | -1.18 | 0.76 |
| C1 | 0.37 | -1.93 | 20.8 | 26 | 0.29 | 0.81 |
| C2 | -0.25 | 0.18 | 20.8 | 51 | -0.28 | -0.71 |
| C3 | 0.47 | 0.68 | 26.7 | 59 | -0.74 | -2.03 |
| C4 | 0.46 | 0.62 | 26.7 | 63 | 0.36 | -0.04 |
| C5 | 0.03 | -0.03 | 25.8 | 52 | 1.16 | 0.08 |
| C6 | -0.17 | -1.41 | 26.7 | 48 | 1.86 | 0.18 |
| C7 | -2.49 | 0.07 | 27.8 | 52 | 0.69 | 0.03 |

Figure 1. Plot ordinated data of the macroinvertebrate community using the first two dimensions of correspondence analysis

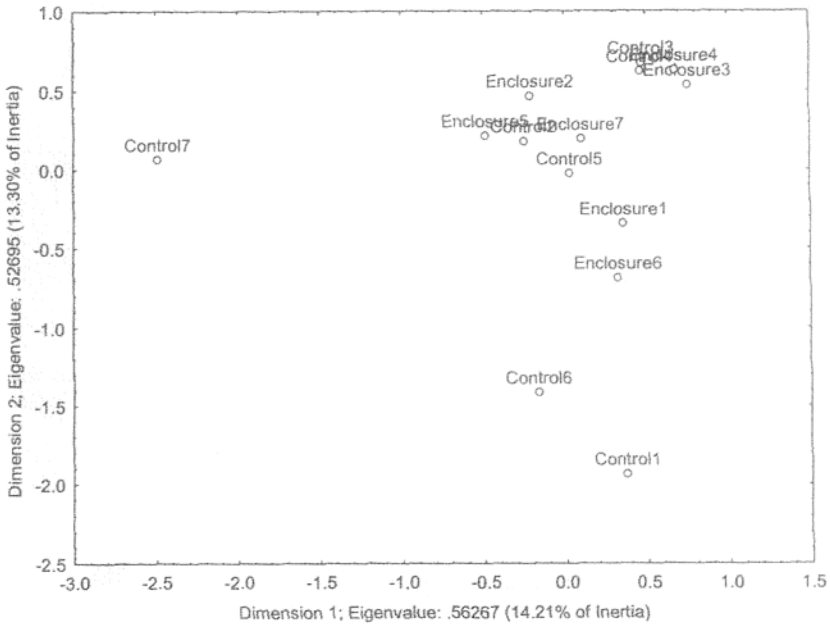


Figure 2. Plot of ordinated data of the flora community using the first two dimensions of correspondence analysis.